The effect of interference on a DBS system during a rain fade, for various interference levels, has unequivocally been documented and demonstrated in these tests.

It is significant to note that Northpoint recently claimed that the DIRECTV system could withstand C/I levels of either 5 or 9 dB and not suffer harmful interference.[12] Figures 3.4.1.1-1 and 3.4.1.2-1 clearly demonstrate otherwise.

As noted earlier, in Figure 3.4.1.1-1 between 4:00 and 5:00, the DIRECTV system exposed to interference (Receiver B, exposed to interference with an approximate C/I ratio of 8 dB) suffered two time periods with complete loss of service. The interference-free receiver did not experience any interruptions during this same time period. In addition, Receiver B saw a much longer period of outage between 6:00 and 7:00 than did Receiver A. In Figure 3.4.1.2-1, the DIRECTV system exposed to interference (Receiver B, exposed to interference with an approximate C/I ratio of 13.7 dB) suffered signal outages. The interference-free receiver did not.

These events are proof that the quality of service has been harmed. Receiver B has suffered both more frequent and longer rain outages than Receiver A has because of the added interference. The amount of increased outage time is directly related to the level of interference. Less interference reduces the amount of added outage time, and this is the basis for one of the two NGSO-FSS/GSO-BSS sharing criteria developed in the ITU-R. This concept of limiting the increase in unavailability is directly applicable to the proposed Northpoint/GSO BSS sharing situation.

3.4.2 DIRECTV Comments on Northpoint Rain Observations

The rain demonstration performed by Northpoint during Hurricane Floyd conceals the true extent of the interference of Northpoint transmitters into DBS receivers.[13] Northpoint would have observed poorer receiver performance with rain and interference had their rain testing been performed at sites exhibiting measurable interference levels, such as at the Iwo Jima site or the Ericsson Memorial/Polo Field site.

Northpoint made their Hurricane Floyd observations at their site number 7, at Arlington Cemetery. First, it must be noted that Northpoint's own signal meter data measured at Arlington Cemetery (site 7) changed over time for DIRECTV

[12] *See* Reply Comments of Northpoint Technology, ET Docket No. 98-206 (April 14, 1999), at 20 ("As Northpoint has previously set out in its comments, DBS service needs a clear-sky C/I ratio of 5 dB from Northpoint to avoid experiencing harmful interference. Even with rain and making worst case assumptions about other sources of noise, DBS providers only need a C/I ratio of 9 dB to avoid harmful interference.").

[13] DIRECTV notes that due to the last-minute nature of the notice provided by Northpoint during this test – the morning of the test – first-hand observation was greatly impeded.

DBS receivers pointed at 101° W.L. Their observed change in signal meter readings went from –5.6 (August 4) to –2.2 (August 12) to 0.1 (August 23). This unexplained change to lower interference levels suggests changes in transmitter configuration, transmit power or beam tilt. This change to lower interference levels is unexplained by Northpoint.

Second, during the time of Hurricane Floyd, Northpoint's own data show that this site continued to exhibit low interference levels consistent with their last observation on August 23. This observation is explained more fully below. **However, observing the impact of interference on DBS availability performance at a site that, for whatever reason, exhibits little interference is clearly no basis from which to extrapolate sweeping claims about the ability of Northpoint to coexist with DBS**. This is especially true considering that there were other sites (Iwo Jima "B", and Ericsson Memorial/Polo Field) where much higher interference levels were measured and where productive observations of the impact of rain on availability could have been taken.

Figure 3.4.2-1 below shows the signal meter variation as a function of time during Hurricane Floyd on September 16, 1999, as reported by Northpoint in its October 1999 Progress Report.[14] As shown in the figure, the lowest observed values for the DIRECTV test receiver signal strength remained above 50 for this rain event. This value is above the video threshold level for both the low and high information rate modes used by DIRECTV. This indicates that the rain fade at this site during this rain event was not sufficiently deep to cause an outage of the DBS signal. Or, to put it another way, the rain rates were not high enough to cause an outage with or without the small amount of interference present at the site on this date.

[14] Northpoint Experimental D.C. Report at 22, Fig. 12.

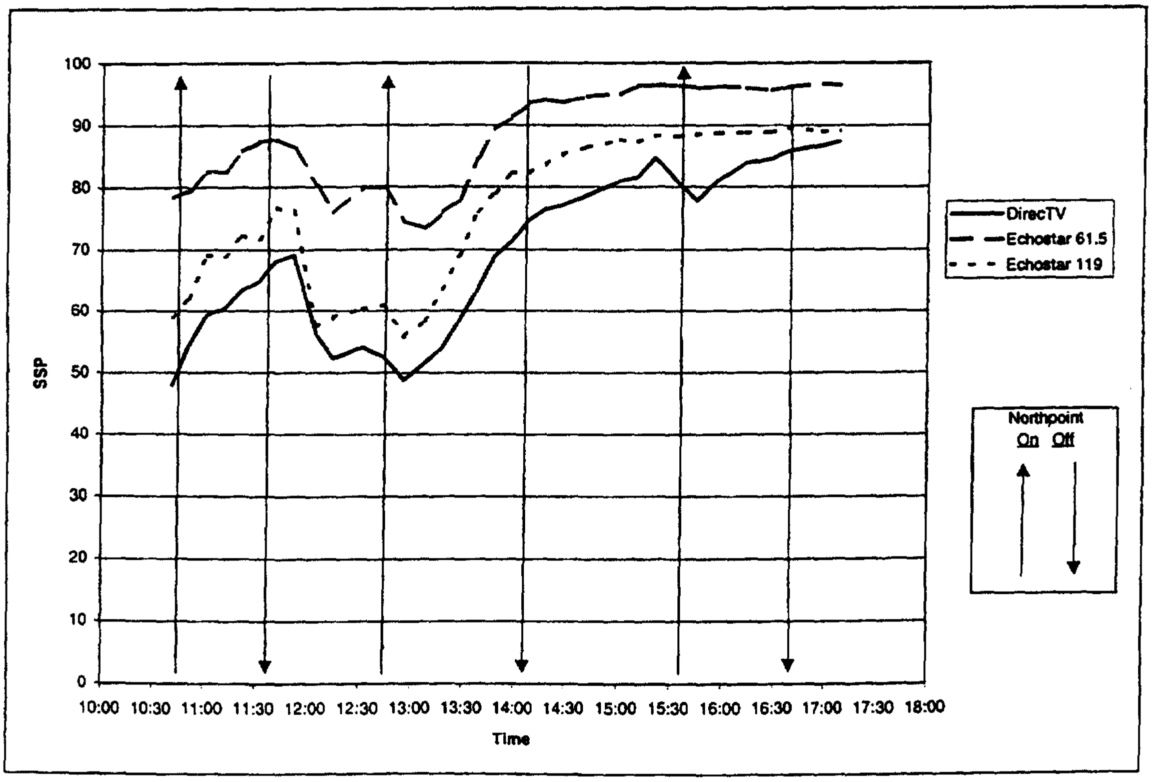

Figure 3.4.2-1: SSP Reading during Hurricane Floyd, September 16, 1999

A low interference environment can be inferred from Figure 3.4.2-1 by looking at each of the times where the Northpoint transmitter was turned on or off. Had there been a measurable level of interference, the signal meter reading (or 'SSP' as it is called by Northpoint) would have changed abruptly at any of the transmitter on or off times. The smooth nature of the 'SSP' curve at each of the transition points indicates that the receivers were, for whatever reason, not picking up significant amounts of interference at this time.

The critical points about Northpoint's observations during Hurricane Floyd are as follows:

1. Despite the "Hurricane Floyd" designation, the rain in Washington, D.C. on September 16, 1999 was moderate in nature, and not what one ordinarily associates with a "hurricane";

2. Northpoint chose a site that, for whatever reason, had a low interference environment, which guaranteed that they would see no impact from their transmitter;

3. The DIRECTV system worked as designed, and withstood this moderate rain event without signal interruption;

4. Had these observations been made by Northpoint at a site such as Iwo Jima B or Ericsson Memorial/Polo Field, the effects on the signal meter of turning the transmitter on would have been clearly observed as a loss in clear-sky margin; and

5. Northpoint could not have demonstrated the difference between outage times with and without interference via their test techniques. A better test configuration is to operate two receivers, one of which is shielded in some way from the interference so as to act as a control receiver.

Lastly, Northpoint has stated that "[n]ot only were no outages observed during the test, no reports of harmful interference were received by Broadwave for investigation."[15] The claim is disingenuous. First, as mentioned, Northpoint deliberately chose a site where the observed interference impact on a DBS subscriber would be minimal or non-existent. The contour surrounding the Northpoint transmitter on the USA Today building consists primarily of the Potomac River and uninhabited parkland, which have a noteworthy paucity of DBS subscribers.

More fundamentally, a DBS consumer whose receiver is receiving Northpoint interference will clearly experience degraded performance during rain. This was established by DIRECTV's New York rain demonstration. However, during a significant rain event, a typical consumer whose receiver is newly exposed to Northpoint interference and who is experiencing poorer receiver performance will probably not be able to identify the source of the problem. The introduction of interference will appear to the consumer *over a period of time* as an increased sensitivity of his or her receiver to rain events. A typical consumer response to such an event is "Gee, why did my signal go away? I didn't think it was raining that hard outside." The connection between poorer performance and a new Northpoint transmit tower in the neighborhood simply will not be one that most consumers will be able to make.

DIRECTV concludes that Northpoint's unscientific demonstration showed, at best, how one DBS receiver behaved during a particular moderate rain event, but not much more. It is certainly not appropriate for Northpoint to draw any conclusions from these tests.

[15] Northpoint Experimental D.C. Report at 22.

4 *Appropriate Protection Criteria*

DIRECTV for years has been very active in the development of protection criteria to protect the BSS from newly-proposed NGSO-FSS systems. These are the first protection criteria to be developed in the ITU since the advent of digital transmission BSS systems.

These protection criteria are directly applicable to the proposed Northpoint sharing situation. First, a digital BSS receiver cannot distinguish between the added noise generated by an NGSO-FSS transmission or a Northpoint transmission; both NGSO-FSS and Northpoint systems are proposed as digital wideband angle modulated signals. Second, the developed criteria are appropriate because they take into account the operational and design characteristics of new digital BSS systems. Finally, these criteria have been under close study and careful review over the past several years by a wide range of international experts on the BSS.

Section 4.1 reviews the development of these criteria in more detail.

4.1 *Review of the Development of NGSO-FSS Criteria*

As developed and implemented by the ITU, the BSS is a "planned" band — a fact which has many implications. When the BSS Plan was established, guidelines and constraints were created for overall BSS system design. For example, the frequency band layout and polarization scheme were established for Regions 1, 2 and 3. Every administration was provided with specific orbital slots to serve their territories. The details of the BSS Plan are provided in Appendices S30 and S30A to the ITU Radio Regulations.

One fundamental provision of the BSS Plan is the control of interference into Plan assignments. Specifically, the interference into a victim BSS system from a proposed modification to another BSS system (that is intra-service interference) is strictly limited. In addition, interference from other types of services (inter-service interference) is also strictly limited. For example, when an administration wishes to put a modified BSS assignment into operation, detailed studies of the interference levels produced by the modified system into other BSS assignments and other services must be provided in the ITU filing.

Recently the 1997 World Radiocommunication Conference (WRC-97) established allocations for NGSO systems. As their name implies, NGSO satellites do not remain stationary over a single spot on the earth's surface. For example, the satellites in one proposed NGSO system would orbit the earth at about 1500 km and circle the globe in about 90 minutes. DIRECTV and other BSS systems serving the United States use satellites in geosynchronous orbits (GSOs). As seen from the ground, GSO BSS satellites are nearly stationary -- a subscriber points his or her antenna towards a fixed point in the sky and no further adjustments are needed.

Also identified in Figure 5.5-1 are various test site locations used by either DIRECTV or Northpoint to measure interference levels during the Washington, D.C. demonstration. DIRECTV test sites are identified as DTV-n, and Northpoint test sites are identified as NPT-n, where n represents the test site identifying number used by the respective group.

The percent values associated with each test site are either calculated or estimated percent changes in unavailability as derived from reported signal meter changes. The values derived from DIRECTV observations are calculated using the specific signal meter versus C/N calibration curve for the actual DIRECTV test receiver. The values derived from Northpoint observations are estimated based on their filed signal meter change observations and this same calibration curve.

Note that the observed degradation in unavailability ranges from 5% to 30% within the green interference zone, except for the DTV-4/NPT-10A site where no signal meter decrease was recorded. Given that the measurements were made by two different groups using somewhat different test techniques and procedures, and given the uncertainty in the true transmit power and antenna direction of the Northpoint transmitter, the results largely confirm the existence of the predicted green interference zone. Recall again that this zone is for receivers looking at the DIRECTV satellites at 101° W.L., and receiving interference that creates unavailability degradation above 10%.

Similarly, Figure 5.5-2 displays the calculated interference zones around the USA Today transmitter for DBS receivers pointed at Echostar's satellite located at 61.5° W.L. The green and yellow regions represent the same interference zones as described in Figure 5.5-1. The are significantly larger than those shown in Figure 5.5-1 because the highest gain of the Northpoint transmit antenna is directed substantially along the 108° sensitive bearing azimuth as described earlier in Figure 2.1.4.1-2.

Again, DIRECTV and Northpoint test sites are identified in the figure, and the impact on unavailability as derived from signal meter change observations are listed.

In this figure all the percent values associated with each test site are estimated percent changes in unavailability as derived from reported or observed signal meter changes. The values derived from DIRECTV observations are estimated using the specific signal meter versus C/N calibration curve for the actual Echostar test receiver used in the test, deriving a C/I value, and then estimating the impact using the curve found in Figure 3.2-1. The values derived from Northpoint observations are estimated based on their filed signal meter change observations, the same Echostar calibration curve to derive a C/I value, and then again using Figure 3.2-1.

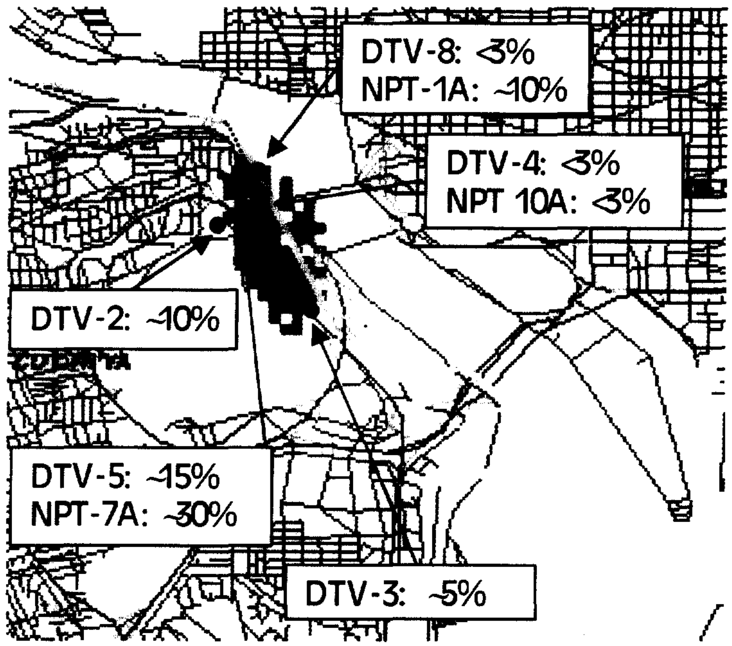

Figure 5.5-2: Predicted Interference from Northpoint USA Today (113° azimuth) into Echostar BSS Receivers at 61.5°

Note that the results show interference significantly above predicted levels, specifically at sites DTV-6 and DTV-7. Site DTV-7 shows about a 13% impact on unavailability, and yet it is outside of the yellow zone where interference should be less than 2.86%. Similarly, site DTV-7 is on the edge of the green zone where the interference level is predicted to be near 10%, but instead was observed to be above 80%.

It is also interesting to note that there was no measurable change in signal meter readings for test receivers at site DTV-9/NPT-3 (the Kennedy Center), indicating an impact of less than about 3%. Levels should have been near the 10% value. Both the higher than predicted results at DIRECTV sites 6 and 7, and the lower than predicted results at DIRECTV site 9 (the Kennedy Center) may indicate that the Northpoint transmit antenna was pointing somewhat south of the reported 113° azimuth angle. In any event, the readings at DIRECTV sites 6 and 7 clearly indicate the presence of an interference zone very similar to those calculated by the OH Loss propagation model.

Finally, it is important to consider the general nature of these interference zones if Northpoint transmitters are deployed in large numbers. Antenna heights will certainly vary, and some transmitters will be placed on buildings and others on towers, changing the coverage and interference patterns. Northpoint has discussed the possibility of locating transmitters on the tops of hills and mountains, but no specific examples have been provided for analysis. Additionally, multiple transmitters will likely be required to illuminate holes in coverage patterns caused by uneven terrain. All of these issues remain very much open ones, and are serious cause for concern that interference would be even greater than predicted.

6 *Investigation of Generalized Interference Zones Shows True Extent of Interference Threat to DBS*

This section summarizes the results of two analytical approaches used to investigate the size and extent of interference zones to protect DBS receivers receiving signals from all practical satellite locations on the geostationary arc.

DIRECTV has clearly demonstrated that adding interference to a BSS receiver will cause harmful degradation to DBS service. It is important to limit this interference so that harmful interference is not realized, and it is important to protect DBS reception at any point in the DBS service area, when receiving DBS signals from any present or future practical DBS orbit location assignment.

Two different approaches have been taken to evaluate the size and extent of these generalized interference zones when protecting reception to all present and future DBS orbit slots. The first technique, discussed in some detail in the previous DIRECTV filing on this subject has the following characteristics[25]:

1. uses a simple propagation model that assumes a flat earth and $1/(4\pi R^2)$ free space loss;
2. protects all positions on the geostationary arc above a minimum 10° elevation angle; and
3. changes the DBS earth station horizon antenna gain pattern for varying elevation angles to the desired DBS satellite.

This approach is described further in Section 6.2. The advantage of this approach is that it is relatively easily performed in spreadsheet programs, allowing different scenarios to be quickly analyzed. It can also predict the behavior of these interference zones for low elevation angles of the DBS receive antenna.

The second approach has the following characteristics:

1. uses a sophisticated and well accepted propagation model (OH Loss);
2. protects specific DBS orbital assignments on the geostationary arc, both domestic and international, that are currently serving the U.S. or may potentially serve the U.S.; and

[25] Section 2.2.4 of Technical Appendix B of March 2, 1999 Comments of DIRECTV (starts on page 13 of App. B)

3. assumes a single DBS earth station horizon antenna gain pattern, for an elevation angle of 40°.

This approach is described further in Section 6.1. The advantage of this approach is that it more accurately takes into account the true terrestrial propagation characteristics at this frequency and takes into account specific terrain characteristics.

Significantly, both approaches provide very similar interference zone characteristics, both in size and shape, and thus can be used to understand the true extent of these zones.

6.1 *Generalized Interference Results Using OH Loss Model*

DIRECTV and Radio Dynamics have performed detailed analyses in order to evaluate the coverage of the proposed Northpoint system and the interference such a system would present to existing DBS systems receiving signals in the 12 GHz band.

As detailed in Section 4, important BSS protection criteria based on unavailability have been adopted by the ITU. These criteria are also applicable to the proposed Northpoint operation. In fact, *all* NGSO systems must adhere to these criteria.

Further, as described in Section 2.1.5, it is critical that provision be made to ensure adequate protection of all DBS satellites serving the United States, both currently operational or that may provide service in the future.

This section describes one method of applying the unavailability degradation limit criterion to the Northpoint interference case. It uses the OH loss propagation model to determine minimum separation distances (and the resulting interference zones enclosed by these separation distances) between DBS receivers and a Northpoint transmitter or transmitter array.

Composite interference zones were generated that protect service from specific DBS orbital assignments on the geostationary arc. These assignments were taken to be either domestic or international, and were those that are either currently serving the U.S. or may potentially serve the U.S. These assignments are listed in Table 2.1.5.1-1.

Two specific cases were generated in order to analyze the interference zones surrounding Northpoint transmit sites in the Washington, D.C. metropolitan area:

a) In the first case, composite interference was analyzed from an array of "well-packed" Northpoint cells into DBS receivers receiving signals from multiple DBS orbital slots. For this case, the

Northpoint USA Today transmitter located in Arlington, Virginia was chosen as the starting point for a "well packed" array of Northpoint transmitters. The adjoining cells and corresponding Northpoint transmit sites for this array were established at regular 16 km intervals. A uniform transmitter pointing direction of 113 was assumed for each transmitter in the array.

b) In the second case, one site in the "well packed" array of transmit sites was chosen for further analysis of composite interference. This hypothetical site is in the vicinity of Vienna, Virginia, 16 kilometers due west of the USA Today site. Northpoint transmit antenna pointing directions of 180 and 113 azimuth were assumed.

Two different protection levels were used in generating the interference zones surrounding Northpoint transmitter sites:

a) In the first, a maximum unavailability degradation of 2.86% was used as the protection criterion. This criterion results in a minimum clear-sky C/I requirement of 27.2 dB. A steady state interfering signal at this level produces degradation in unavailability equivalent to that allowed for any *one* NGSO-FSS system.

b) In the second, a maximum unavailability degradation of 10.0% was used as the protection criterion. This criterion results in a minimum clear-sky C/I requirement of 21.9 dB. A steady state interfering signal at this level produces degradation in unavailability equivalent to that allowed by *all* NGSO-FSS systems.

Then, the corresponding isotropic received signal strength (RSSi) at which Northpoint transmissions would introduce unacceptable interference into the BSS system was calculated. See Appendix A, Table 3 for details of these calculations.

The assumptions and analytical results used in predicting these interference zones are described below.

6.1.1 OH Loss Model Assumptions

The NSMA OH loss propagation model was used to predict interference zones in the Washington, D.C. area. This model is the most recommended standard model for computing propagation of RF signals with frequencies between 2 and 38 GHz. The model assumes different modes of propagation depending on the geometry and terrain of the path between the transmitter and BSS receivers. Also, it uses calculations associated with several classes of diffraction, scattering and irregular terrain. Radio Dynamics software coded this propagation model in order to analyze the coverage and interference zones surrounding Northpoint transmitters.

Table 6.1.1-1 lists the key assumptions and Northpoint transmit characteristics used in this analysis. In this model, interference zones were predicted using key transmit characteristics made available in Northpoint's public filing with the Commission.[26] For these predictions, the Northpoint transmit site on the USA Today building in Arlington, VA was used as a base site. The coordinates used for the USA Today transmit site were 77-04-07.0W and 38-053-36.0N. The antenna height was taken to be 453 feet above ground level (AGL). Published Northpoint antenna characteristics were used, and generally can be characterized as having a 110 horizontal beamwidth and 17.5 vertical beamwidth. The DBS victim receive antenna was taken to be 10 meters off the ground, and a measured horizon antenna gain pattern at a fixed elevation of 40 was used in these analyses.

Parameter	Assumptions
Number of Transmit Cells	5
Transmit Coordinates (USA Today)	38-53-39N 77-04-07W
Transmit Antenna Beamwidth Vertical Horizontal	 17.5° 110°
Antenna Height (AGL)	453 ft.
Effective Isotropic Radiated Power	12.5 dBm
Interference Threshold 10% increase in Unavailability 2.86% increase in Unavailability	 -142.5 dBm -147.8 dBm
Beam tilt	3°
Transmit Mainbeam Direction	113° Azimuth 180° Azimuth
Transmitter Spacing	16 Kilometers

Table 6.1.1-1: Assumed Northpoint Transmit Parameters

[26] Reply Comments of Northpoint Technology (May 5, 1998), Appendix "Link Budgets and Sample Calculations," and Appendix "Delawder Communications," Exhibit 1.

Table 6.1.1-2 lists the propagation effects that have been included in the analysis.

Pointing Loss	Included
Terrain Effects	Included
Atmospheric Absorption	Included
Rain Noise	Included

Table 6.1.1-2: Propagation Effects Included in the Analyses

6.1.2 Composite Interference From an Array of Northpoint Transmitters Based on USA Today Transmitter Site

Figure 6.1.2-1 shows the calculated composite interference zones around the Northpoint USA Today site into receivers receiving DBS signals from all of the DBS orbital assignments listed in Table 2.1.5.1-1. In this figure, yellow represents interference levels above that allowed for *one* NGSO-FSS system; and green represents interference levels above that allowed for *all* NGSO-FSS systems combined. Note that this figure effectively combines the results of Figures 5.5-1 (Interference related to the 101° W.L. DBS assignment) and 5.5-2 (Interference related to the 61.5° W.L. DBS assignment), as well as interference zones related to reception from all of the other DBS orbital assignments listed in Table 2.1.5.1-1.

In Figure 6.1.2-1, notice that the yellow interference zone associated with interference levels above that allowed for one NGSO-FSS system extend well into the populated areas of Washington, D.C., and down into populated areas south of Arlington National Cemetery. The extent of these interference zones is clearly unacceptable, especially if the unpopulated areas (the parkland, Arlington Cemetery or the Potomac River) were instead filled with homes and businesses.

Figure 6.1.2-1: Impact of USA Today Northpoint Transmitter when Considering Reception from Multiple DBS Orbital Assignments

It becomes important, then, to analyze the impact on the greater Washington, D.C. area if it were to be served by an array of such transmitters located throughout the area. Site characteristics, such as those found at the USA Today building with its very tall structure and neighboring fairly uninhabited regions, will not typically be found at neighboring transmit sites if reasonably complete coverage of the greater Washington, D.C. area is to be realized. Once one to two sites have been established in an area, then the other transmit sites must be located in a reasonably regular array relative to these starting points.

DIRECTV and Radio Dynamics analyzed the effect on the Washington, D.C. area of a regularly spaced array of Northpoint transmitters, using the USA Today site as the starting point. The cells in the array were spaced 16 km apart, matching the typical cell size reported in Northpoint filing.[27] Five Northpoint transmit cells were defined for this study, each having a transmit antenna pointing azimuth of 113 , equal to that used at the USA today site. The transmitter height was lowered from the USA Today height of 453 feet AGL to 250 feet to provide for a more typical value.

Figure 6.1.2-2 shows the results of this study. The total interference level calculated for all points within each cell was the aggregate interference from all Northpoint transmitters in the array, as calculated by the OH Loss propagation model, and for reception from all of the DBS orbital assignments listed in Table

[27] Comments of Northpoint Technology (Mar. 2, 1999), Technical Annex at 2, Table 1.

2.1.5.1-1. Yellow and green represent the same interference zones described for Figure 6.1.2-1.

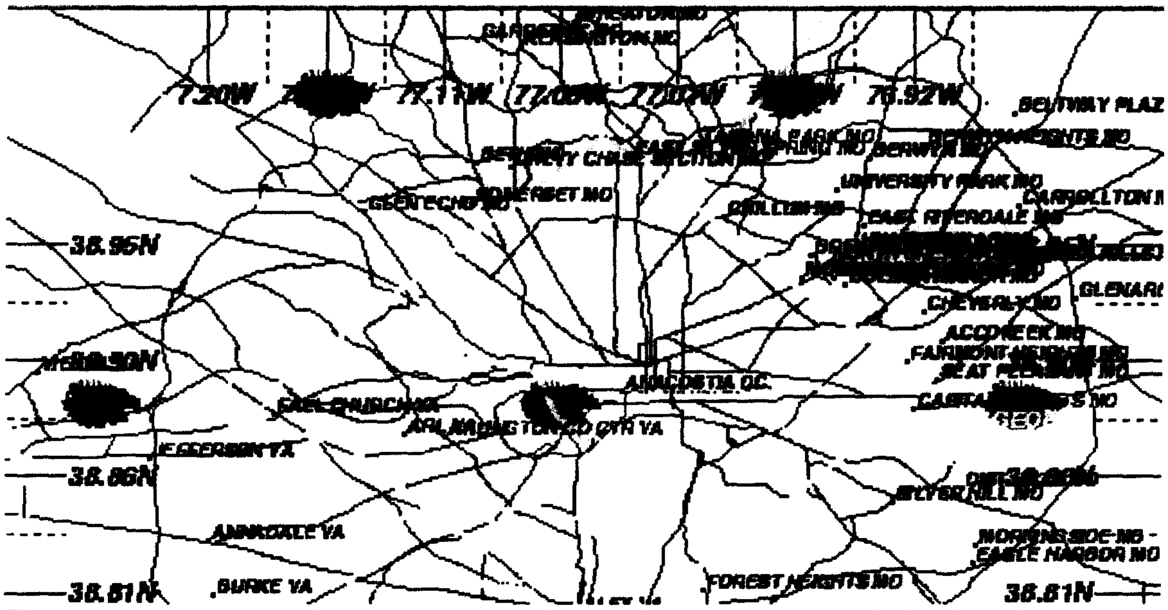

Figure 6.1.2-2: Interference Zones Caused by an Array of Northpoint Transmitters Serving the Washington, D.C. Area

Note that the interference zones are now located in some heavily populated suburban areas. The Vienna, Virginia-based cell, located at the lower left of Figure 6.1.2-2, is one example. The interference zones created by this transmitter location are shown in more detail in Figure 6.1.2-3. The yellow interference zone extends at least 5 kilometers east to west over well-populated areas. In particular, the green interference zone extends up to Route 66, and the yellow interference zone extends across Routes 66, 29 and 50 and across Interstate 495, which runs north to south just to the right of picture center. It is difficult to imagine how this site might be moved to reduce the interference impact on this residential area. Moving the site to the west will create an unserved area between this cell and the USA Today cell. Moving this site to the east will not help because the entire area is well populated.

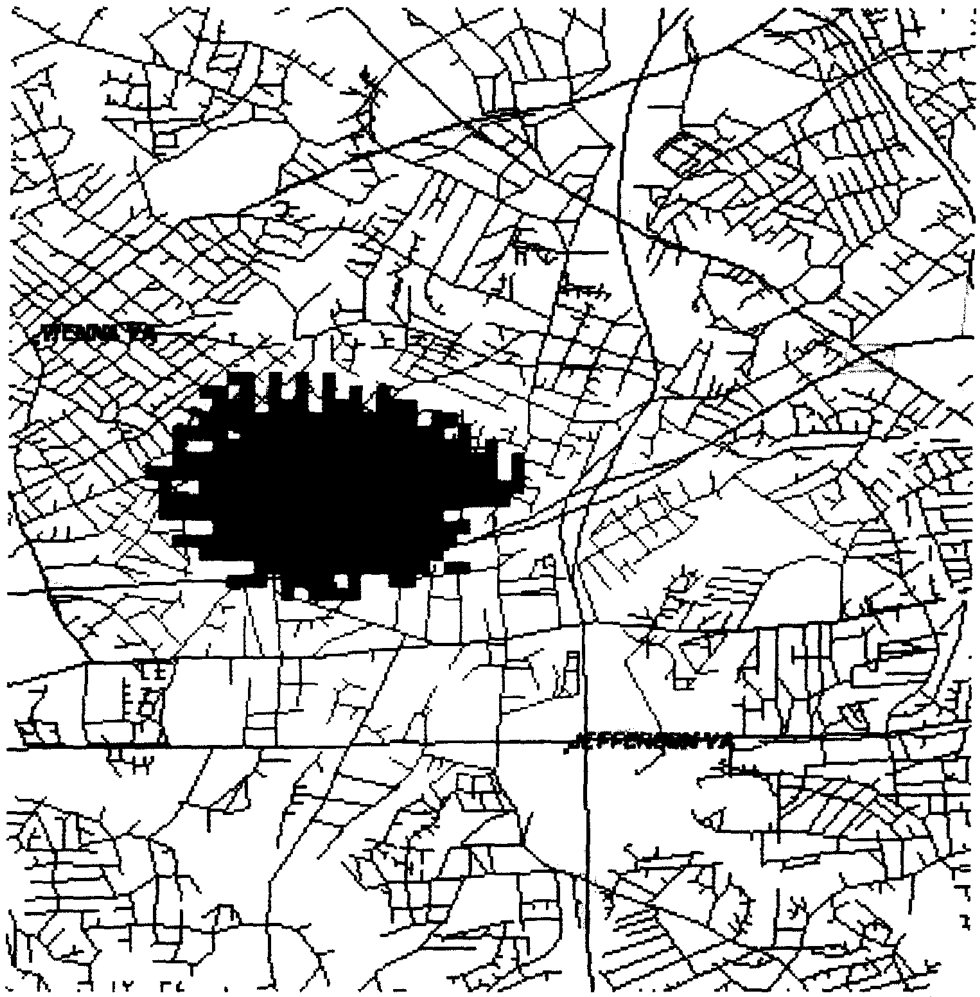

Figure 6.1.2-3: Interference Zones Created by the Vienna, VA Cell Site West of the USA Today Cell Site

It is also important to note that additional Northpoint transmitters may be needed within the "well packed" array to fill in holes in the Northpoint coverage area. These holes are caused by local terrain. Figure 6.1.2-4 is an analysis of the coverage area provided by the "well packed" array established in Figure 6.1.2-2. This figure was also generated using the OH Loss propagation model. Green represents the Northpoint coverage areas. Yellow indicates areas where the signal will be receivable under clear-sky conditions, but the availability performance of the Northpoint system will be less then their stated goal. Red represents areas where the Northpoint signal will not be received.

Note that there are significant (red) areas to the left of picture center that are not served by the "well packed" array. Providing service to these areas with additional transmitters will only serve to increase the already unacceptable density of interference zones shown in Figure 6.1.2-2.

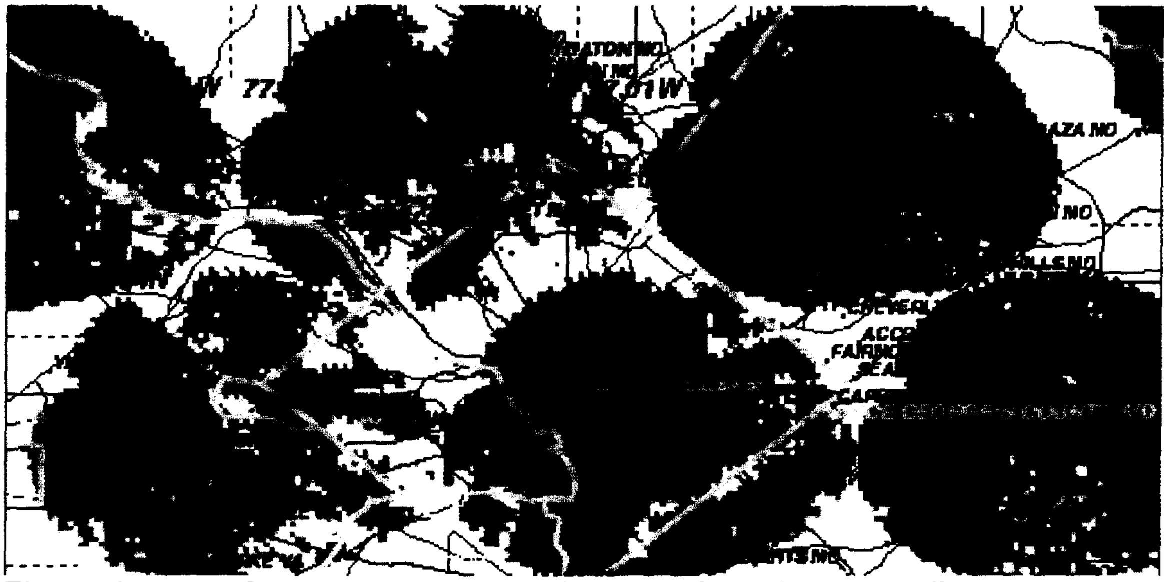

Figure 6.1.2-4: Coverage Analysis of the "Well packed Array"

6.1.3 Example of Composite Interference for a Transmitter Azimuth Angle of 180°

Figure 6.1.3-1 shows the calculated interference zones for a Northpoint transmitter located at the Vienna cell site but using a pointing azimuth of 180° instead of 113°. As in Figure 6.1.2-3, the interference is calculated for reception from all DBS orbital slots listed in Table 2.1.5.1-1. Green represents interference levels above that allowed for *all* NGSO-FSS systems combined; and yellow represents interference levels above that allowed for *one* NGSO-FSS system.

The analysis illustrates how the interference zone changes shape as the azimuth angle is changed from 113° to 180° (due south). As shown, the interference affects a broad area that runs from the Falls Church city line across Route 495 into the heart of Vienna. This area extends south across Route 66, Arlington Blvd (Route 50) and Lee Highway (Route 29). The affected area includes most of the western half of Vienna as well as smaller communities, such as Jefferson. The affected area extends across Route 66, Arlington Blvd (Route 50), and Lee Highway (Route 29). As noted in Section 2.1.5.2, the population within the yellow interference zone is likely in excess of 20,000 people.

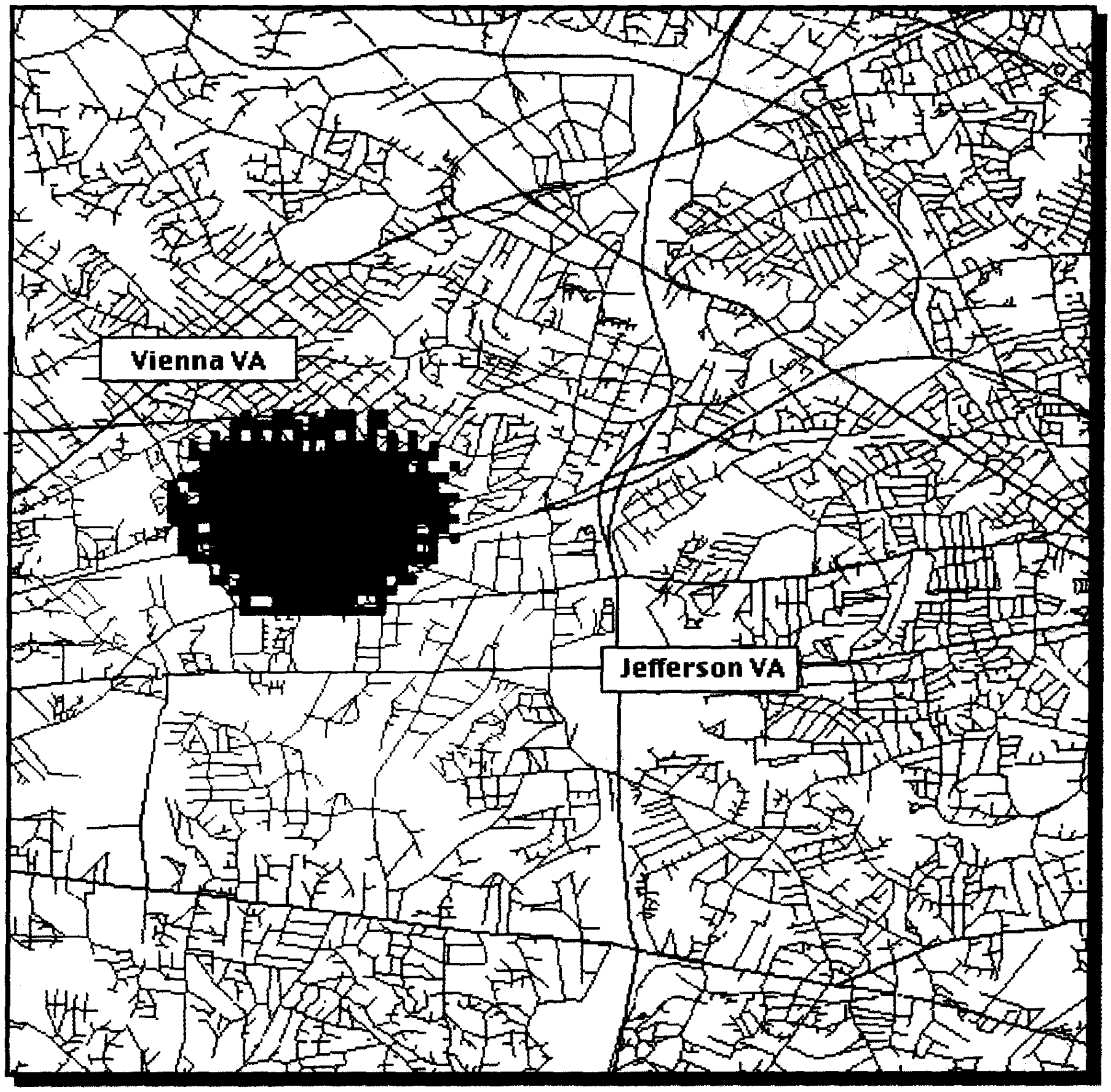

Figure 6.1.3-1: Example of Composite Interference for a Transmitter Azimuth Angle of 180°

6.2 *Generalized Interference Zone Results Using the Flat Earth Model*

The second method for calculating interference zones involves the use of a simple flat earth propagation model, but takes into account the change in the DBS antenna horizon gain as the antenna is moved from DBS orbit slot to DBS orbit slot with the resulting change in elevation angle.

6.2.1 Development of Worst Case Horizon Gain Template

As described in Section 2.1.4.1, it is necessary to take into account the worst case horizon gain for a DBS receive antenna when calculating interference zones. In this case, it is important to develop what might be called a worst case horizon gain template. This template represents the worst case horizon gain in any given azimuth angle direction from the DBS receive antenna when calculated over the entire range of potential pointing directions toward the geostationary arc.

The first step in developing this template is to start with patterns of worst case horizon antenna gain at various elevation angles. For example, in Section 2.1.4.1-1 a typical DBS receive antenna horizon gain pattern was presented. This figure represents the horizon gain for an elevation angle of 40 above the horizon.[28] Patterns for lower elevation angles are also needed, and are shown below.

The next step is to combine these patterns in such a way as to record the worst case horizon gain at any azimuth angle when the DBS receive antenna is allowed to point at any location on the geostationary arc. This is done by effectively pointing or moving the antenna through a series of points along the geostationary arc and recording the worst case gain. That is, the high gain points of the horizon gain pattern will trace out the worst case gain template. This sequence is shown in Figures 6.2.1-1a through d. Notice that the horizon gain pattern does not change significantly until the elevation angle becomes quite low in Figure 6.2.1-1d, where the longitude separation of 65 results in a DBS receive antenna elevation angle of near 10 .

Note that the horizon gain template is not developed relative to the antenna main beam axis, but is developed relative to the compass points – north, south, east and west.

[28] The data source for this pattern can be found in Figure 2.3-2 on page 10 of "Terrestrial Interference in the DBS Downlink Band," an analysis submitted to the FCC on April 11, 1994.

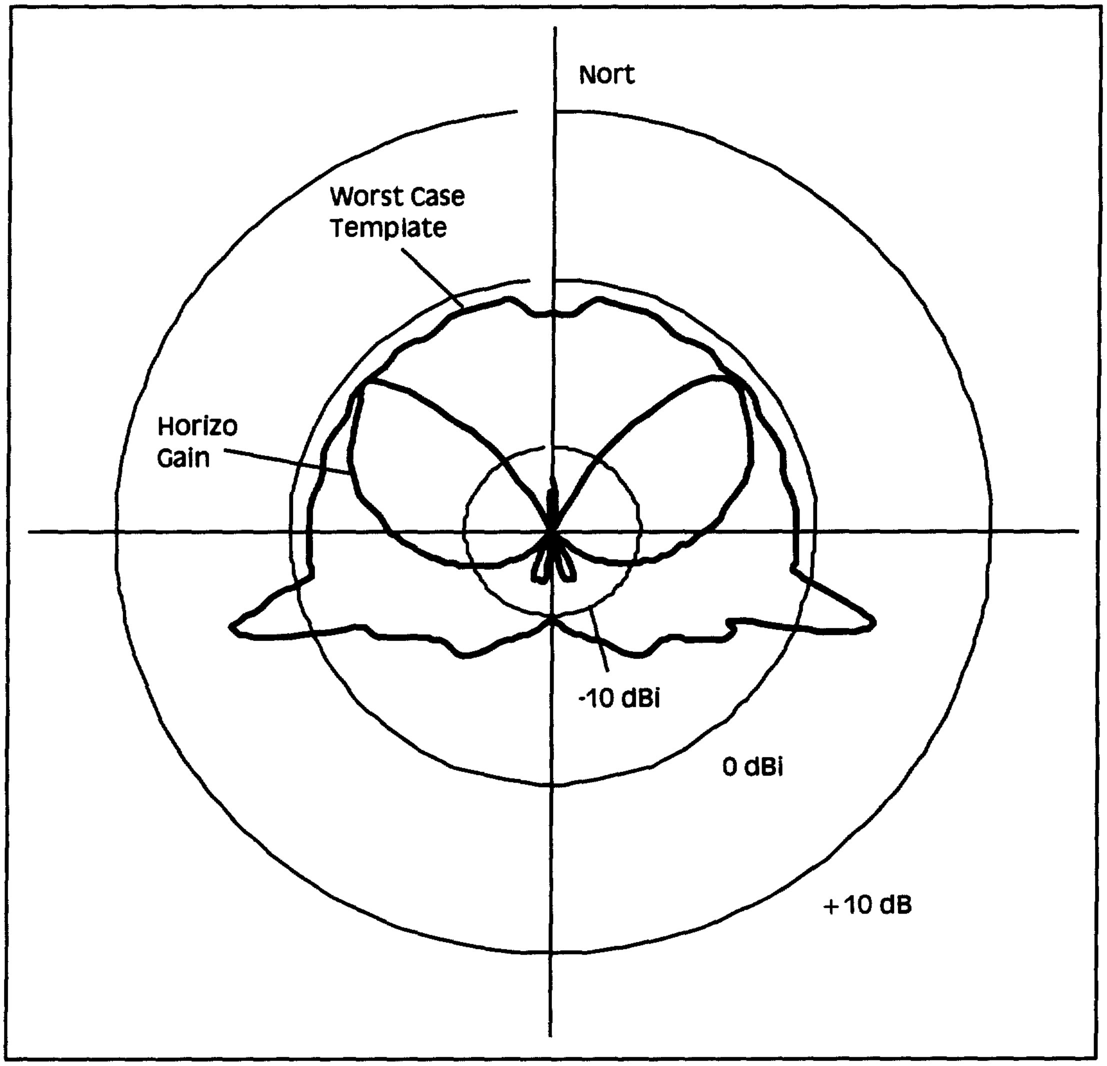

Figure 6.2.1-1a:
Typical DBS Antenna Horizon Gain Pattern
1 degree Longitude Separation, Receive Antenna and DBS Satellite

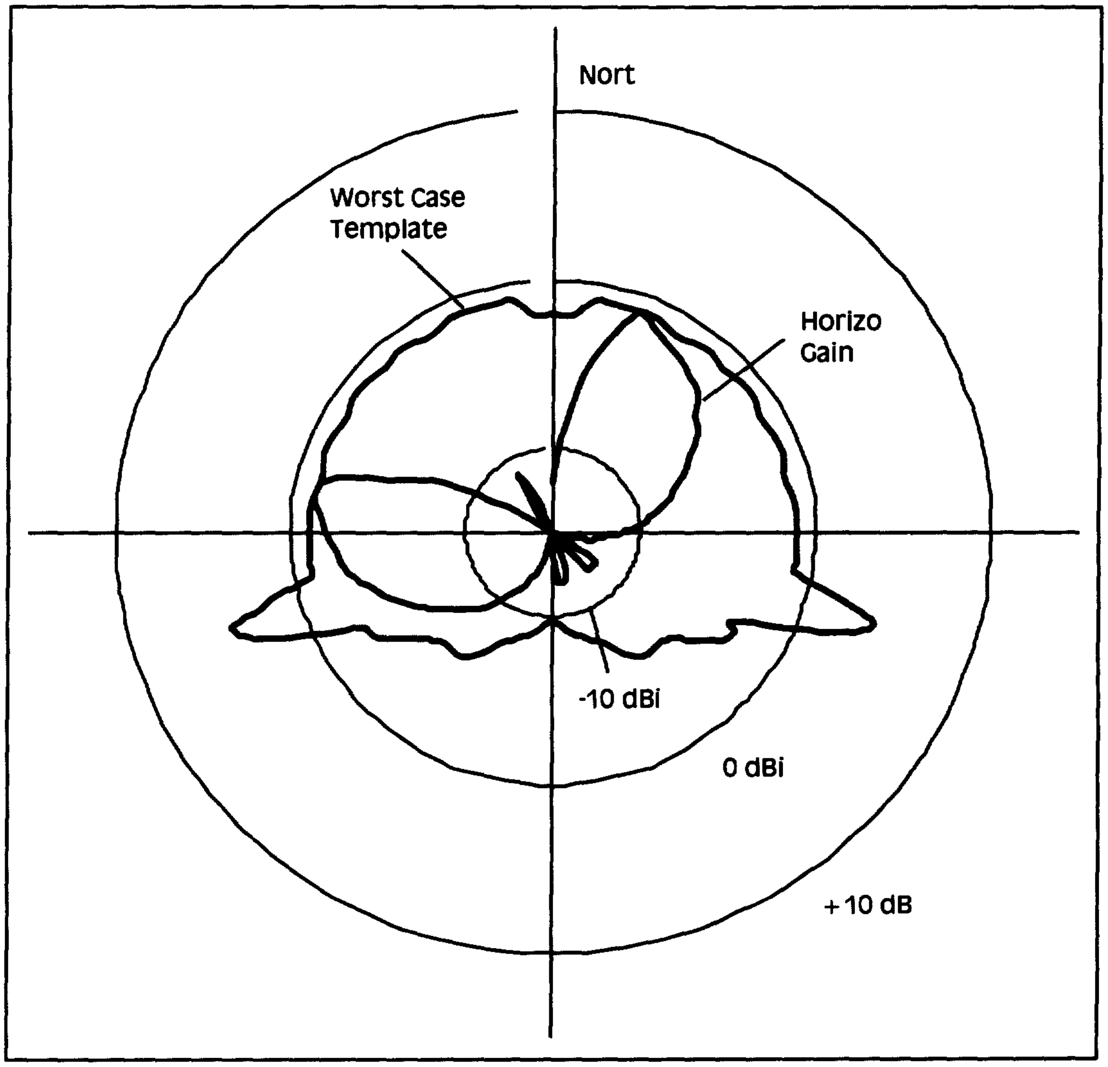

Figure 6.2.1-1b:
Typical DBS Antenna Horizon Gain Pattern
20 degree Longitude Separation, Receive Antenna and DBS Satellite

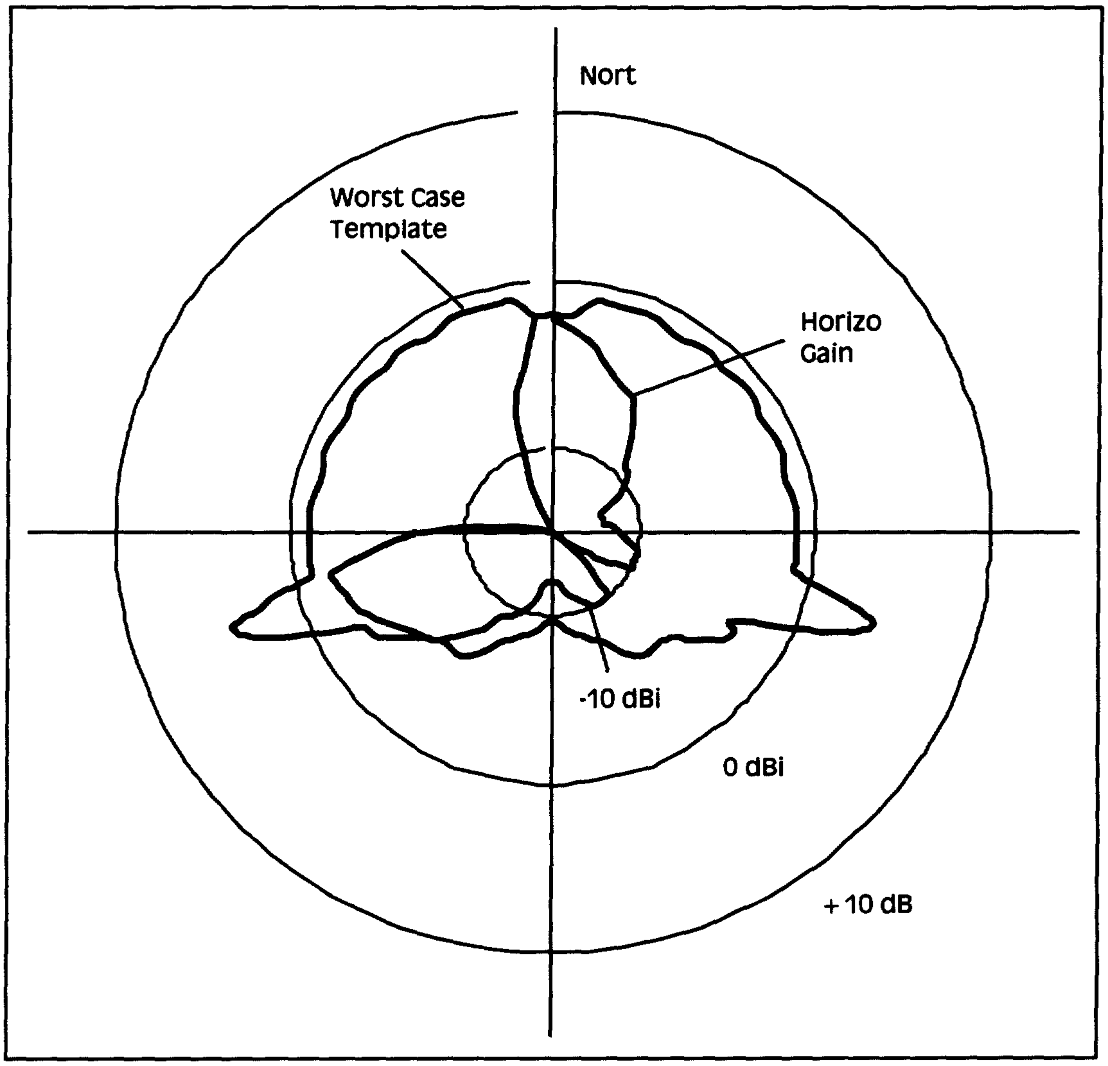

Figure 6.2.1-1c:
Typical DBS Antenna Horizon Gain Pattern
40 degree Longitude Separation, Receive Antenna and DBS Satellite

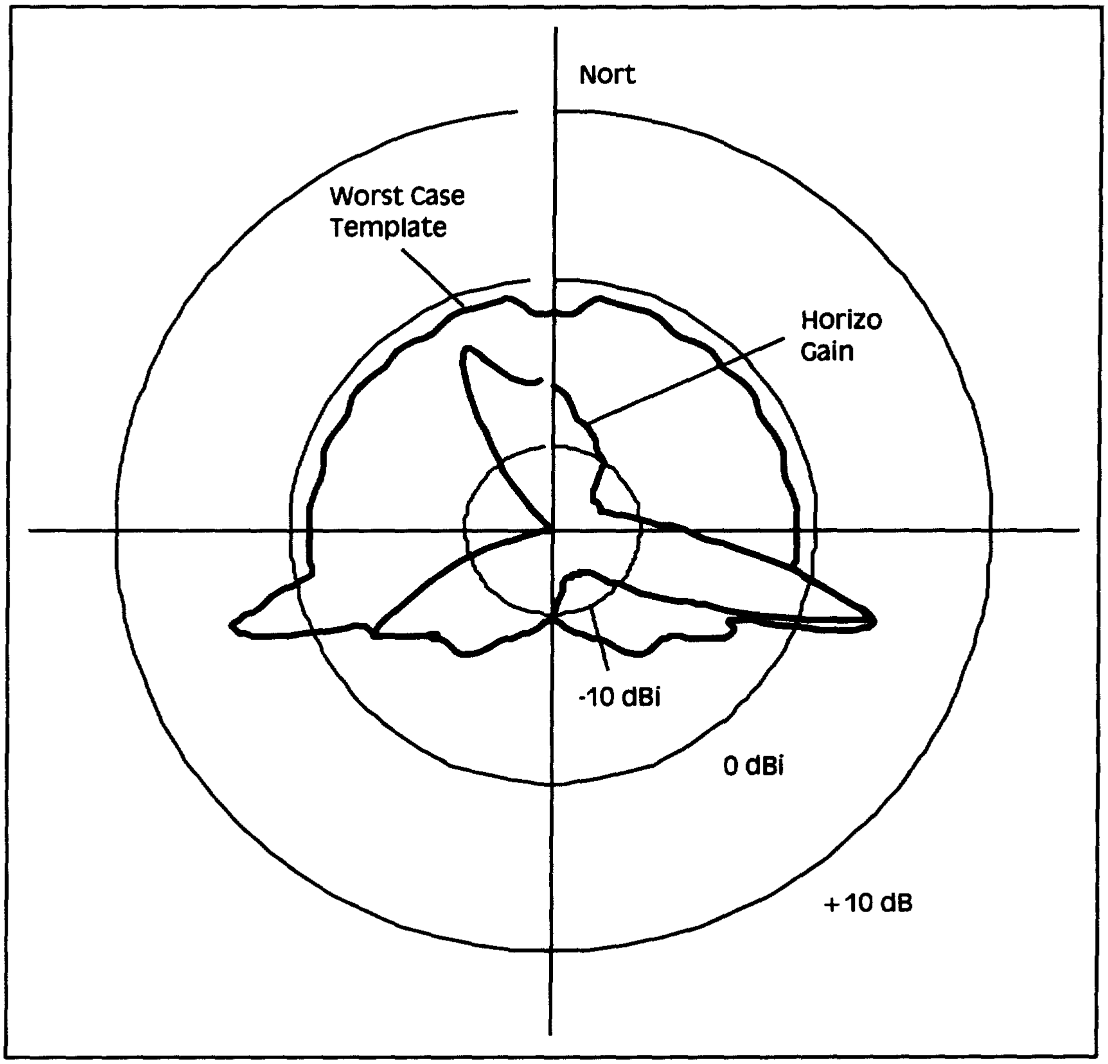

Figure 6.2.1-1d:
Typical DBS Antenna Horizon Gain Pattern
65 degree Longitude Separation, Receive Antenna and DBS Satellite

The result of this sequence is the development of the worst case horizon gain template, also shown in these figures. This template is used in the next section to develop the interference zones.

6.2.2 Interference Zone Calculation

The development of the interference zone becomes relatively straight-forward once the worst case horizon gain template has been developed. It is simply a matter of calculating, at every azimuth angle direction from the interference source (the Northpoint transmitter), the minimum separation distance required from the transmitter to meet the protection requirement. In this case, the calculation must take into account the Northpoint transmitter transmit power and antenna gain pattern, and the DBS antenna worst case horizon gain template.

The following isotropic received signal strength (RSSi) values have been assumed in the calculation of the Northpoint coverage area and the interference zones:

Minimum RSSi at edge of Northpoint coverage area:	-156.0 dBW
Seattle, Washington Area	
Maximum RSSi, 10% unavailability change	-146.8 dBW
Maximum RSSi, 2.86% unavailability change	-152.1 dBW
Washington, D.C. Area	
Maximum RSSi, 10% unavailability change	-142.5 dBW
Maximum RSSi, 2.86% unavailability change	-147.8 dBW

Table 6.2.2-1: Assumed RSSi Values for Interference and Coverage Zone Calculations

A discussion of the above RSSi values can be found in Appendix A.

6.2.3 Interference Zone for Southerly Directed Northpoint Transmission

The interference zone calculations shown in the following figures have been updated since the March 2, 1999 comments of DIRECTV. The two significant differences are that the assumed number of NGSO-FSS systems to be used in aggregate interference calculations has been decided, and a worst case horizon gain template is used instead of a uniform value of 0 dBi.

Figure 6.2.3-1 shows the results of these updated interference zone calculations for a southerly directed Northpoint transmission in the Seattle, Washington area. The calculated Northpoint coverage area and two interference zones are shown. Inside the "2.86%" zone, the calculated interference levels create an unavailability impact that is greater than 2.86% when looking at one or more points on the geostationary arc. Inside the "10%" zone, the calculated interference levels create an unavailability impact that is greater than 10% when looking at one or more points on the geostationary arc.

Note that the calculated interference zones in Figure 6.2.3-1 are somewhat smaller than the interference zones shown in Figures 2.2.4-2, 3 and 4 of the March 2, 1999 comments of DIRECTV. The single interference zone in that document was called the "Area of Unacceptably High Interference," and corresponded to interference levels higher than that generated by one NGSO-FSS system. There are two reasons that the "2.86%" interference zone in Figure 6.2.3-1 is smaller and of slightly different shape than the "Area of Unacceptably High Interference" of Figures 2.2.4-2, 3 and 4 of DIRECTV's March 1999 filing.

The first is that in the interim period between the March DIRECTV filing and the writing of this report, the ITU-R has decided that the equivalent number of NGSO-FSS systems to be used in aggregate interference calculations is 3.5. DIRECTV assumed that this value was 5 systems in its March 1999 filing, and this set the limit on the unavailability impact caused by one NGSO-FSS system at 2%. With the decision to adopt a value of 3.5 systems, the limit on one NGSO-FSS system is now 2.86%. This results in less stringent RSSi values for the updated calculation.

The second reason concerns the shape of the interference zone. Figure 6.2.3-1 was generated using the worst case horizon gain template developed in Section 6.2.1. The interference zones in Figures 2.2.4-2, 3 and 4 of the March 1999 DIRECTV filing were generated using a uniform worst case horizon gain of 0 dBi (*i.e.*, the worst case horizon gain template was assumed to be a circle with a uniform horizon gain value of 0 dBi).

Figure 6.2.3-2 examines the size of the interference zones when moving to the Washington, D.C. area but maintaining a Northpoint transmitter azimuth angle of 180°. The change in size of the interference zones is due to the increased DBS spacecraft EIRP in the Washington, D.C. area. It should be noted that the Seattle interference zone calculations are representative of the lower EIRP values of DBS service throughout the west. The higher satellite EIRP available in the Washington area raises the maximum allowed RSSi values in the Washington, D.C. area calculations, reducing (but clearly not eliminating) the size of the interference zones. The size of the interference zones in Figures 6.2.3-1, -2 and -3 are clearly all unacceptable for DBS service.

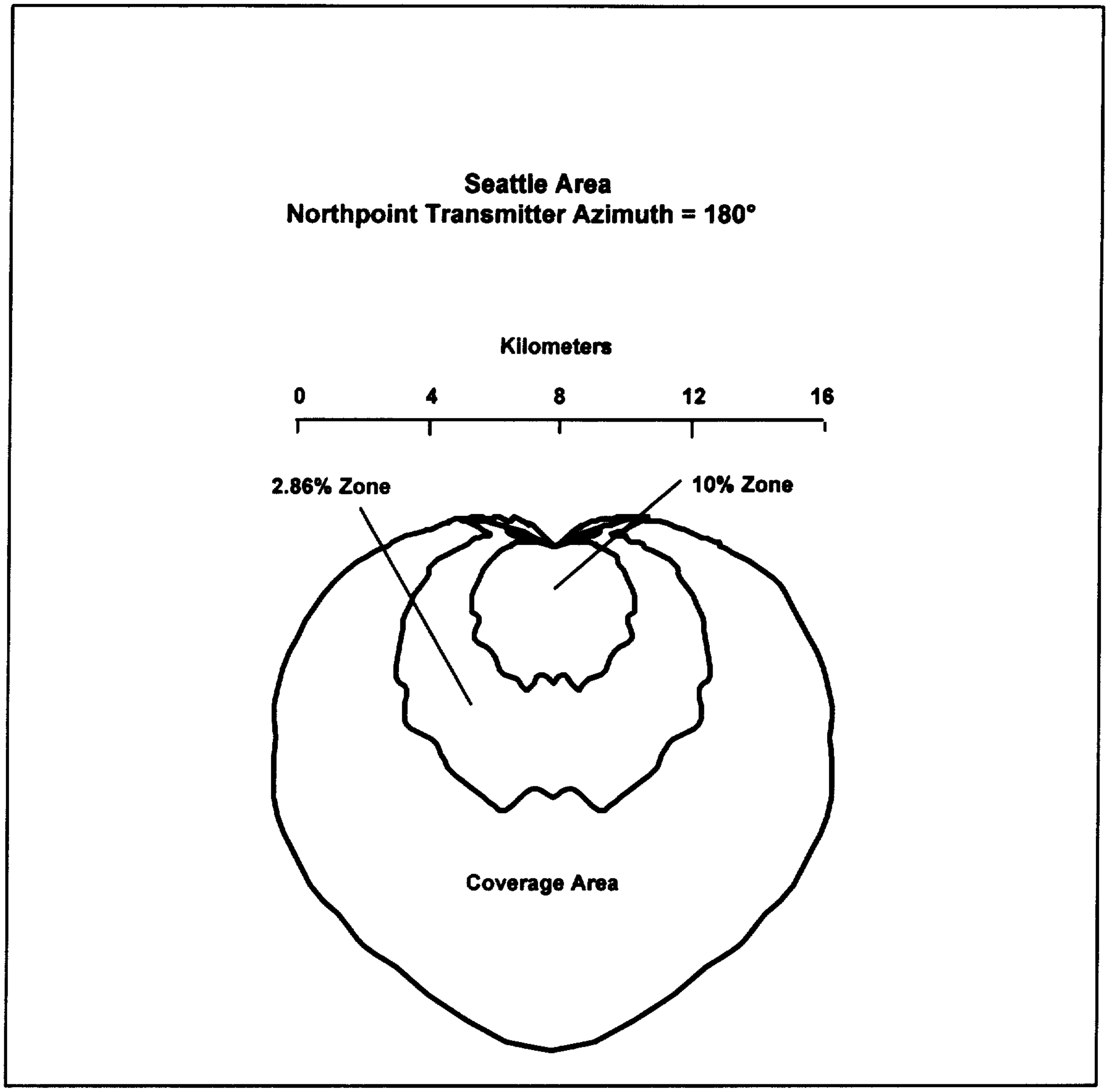

**Figure 6.2.3-1:
Interference Zones, Southerly Directed Terrestrial Transmission,
Seattle, Washington Area**